

PRODAG 50



computing control systems

Ever since the development of the electric motor, there has been a growing need for better, faster and more reliable control systems. To meet this need Westinghouse pioneered advanced systems: first electromechanical, then static. Long and intimate experience with industrial conditions, atmospheres, practices, and problems gave Westinghouse the strong foundation from which these new systems came.

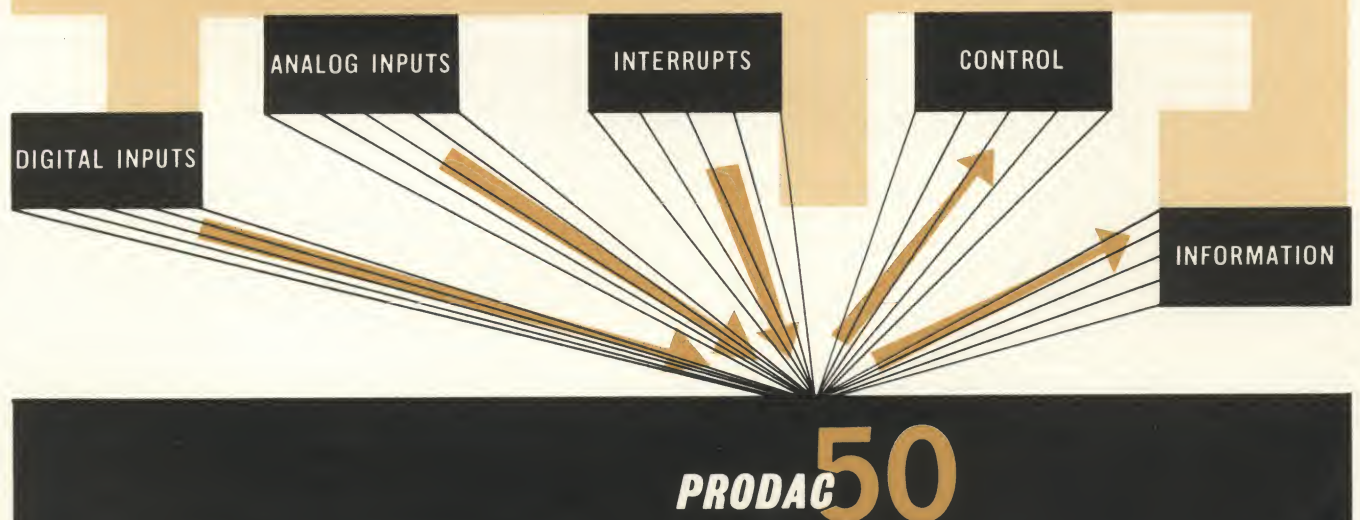
Experience with static control systems led naturally to the development of control systems based on digital computers—a major effort, taking years. The results were worthwhile, because for large, complex applications *only* computer-based systems can provide the control desired. Further, computer control can provide additional benefits: increased process knowledge, better records, closer tolerances, etc.

The cost of these systems, however, limited them to extremely large projects.

Now, from Westinghouse, comes a totally new scope in industrial control systems . . . the PRODAC 50, the first system especially designed to extend the advantages of computer control to every industry—even to small plants—at a cost lower than conventional control.

Westinghouse PRODAC 50 **Computing Control Systems**

*reliability
speed
flexibility to grow*



Westinghouse **PRODAC** 50

Computing Control Systems

can reduce process costs
improve product quality
increase profitability

Westinghouse has designed, developed, and now offers the PRODAC 50, a computer-based control system, to meet the specific needs of small and medium-size plants.

why is computer control better?

In general terms, computer control has greater speed and flexibility. Its speed is such that it can keep close watch on thousands of points in a plant constantly, giving closer supervision than is economical with conventional systems. It can sequence many operations, not only according to a fixed plan, but according to a plan constantly revised to be most efficient. The PRODAC 50 can exercise "judgement"; programs stored in memory can compensate for erroneous input signals—something which is impossible with conventional control systems. Changes in plant operation can be accommodated by simply changing the program. In the PRODAC 50 this is done with a typewriter, not with a soldering iron.

Further, the PRODAC 50 system is "compatible"—meaning that it is so designed that it can communicate directly with other computers. With the larger and more powerful Westinghouse PRODAC 500 Series Computer Systems, this communication can be on a direct channel. If your needs (present or

anticipated) require it, you can readily form a "hierarchy" of computers, with PRODAC 50's controlling portions of a large and complex process, and a PRODAC 510 or 580 system performing an optimization function.

what can it do?

PRODAC 50 systems can be used to record data, provide operator guides or exercise complete control. The system can be installed to do data logging, initially. As the computer develops more complete and accurate information on the plant, its role can be increased to provide guidance to the operator on optimum operation. The same system can be modified (by addition of modular hardware and program changes) to control the process directly, if desired. Any combination of these functions can be used—some operations can simply be logged, others can be monitored and compared with limits, some can be sequenced, while still others can be under complete computer control.

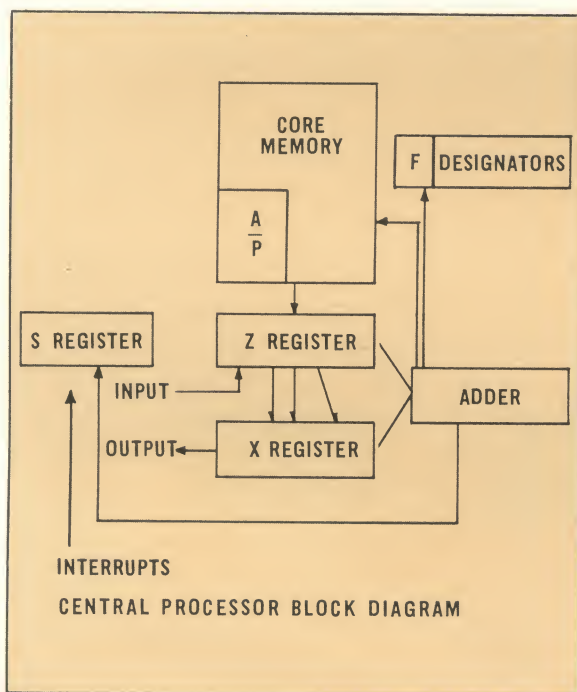
The user can program the computer to produce the control desired, or Westinghouse can provide the programming or "software" on an economical contract basis. Westinghouse can also provide training for personnel in programming, basic computer orientation, and maintenance. If it is desired, Westinghouse also can provide maintenance service on a purchase basis.

what about cost?

While the requirements of each application will differ, it is possible with the PRODAC 50 to put together a system for less than \$50,000, including application programming. Programming is frequently priced separately, although Westinghouse can help reduce this cost by providing standard subroutines at no cost. These include both arithmetic routines (square root, sine, cosine, etc.) and utilization routines (analog input, basic scan, executives, etc.). Adaptation of these to the individual needs of a plant is available at modest cost.

The actual cost depends on the magnitude of the job—the number and frequency of inputs, the degree of control and the amount of data recorded. A very large installation might be as much as \$150,000 while just the central processor with programmer's console sells for less than \$25,000.

A Westinghouse PRODAC 50 Control System can cost no more than so-called "conventional" control schemes, and in many instances less. And the PRODAC 50 provides far more, functionally.



how small is small?

Physically, a complete operating system may be installed in a space no larger than a desk!

Financially, the cost of a PRODAC 50 is frequently no more than the cost of a conventional control system.

Economically, the investment is so low that a PRODAC 50 can be fitted to a plant simply to record data on plant operations.

Electrically, most systems will require less than 300 watts, need no supplemental cooling or elaborate emergency power.

how big a job can it handle?

For data logging and control, the PRODAC 50 system is as fast as many of the "big machines" costing much more, on the market today. It has the capacity for controlling the equivalent of 150 analog loops, or a paper machine, or sequencing a rolling mill, or just about any other process with this level of complexity.

In most applications where the PRODAC 50 is being used as a controller, it will also be necessary and desirable to do considerable data logging. In this context, data logging can mean not only direct recording of events and conditions, but also trends, averages, limits, etc. Production recording is readily available for management reports.

can it grow?

The ability to enlarge and modify the control system as additional functions are brought under its control, or as the plant itself expands, is inherent in the design.

For example, initial use of the PRODAC 50 system may be just for data logging. Thereafter, the user may successively add new duties: monitoring and alarming, analog loop set point control, direct digital control, or combinations of these.

Since the computer "hardware" is standard, and modular, it is easy and practical to field-expand it and modify the computer programming as need may dictate.

is it reliable?

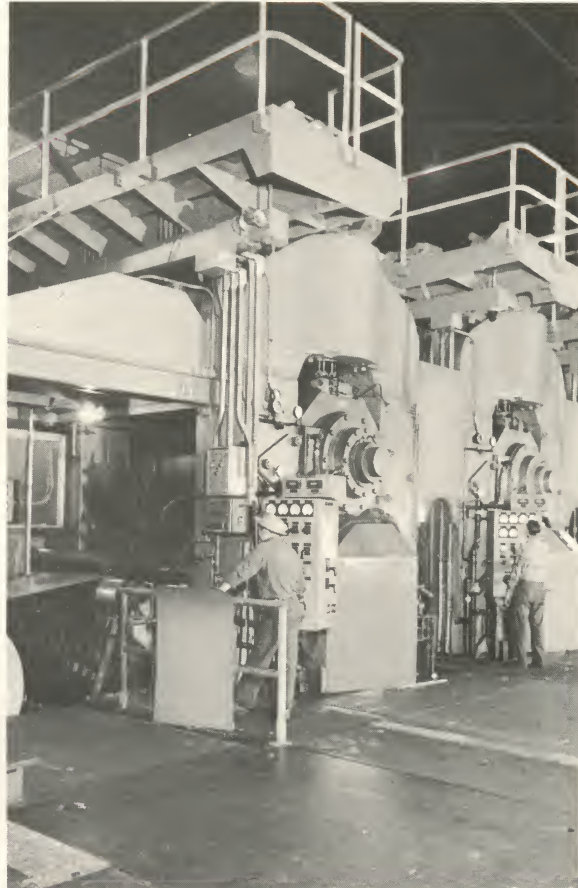
Westinghouse designers and engineers have achieved the near-ultimate in reliability in the PRODAC 50 system in two ways: (1) elimination of "nice-but-not-necessary" hardware within the bounds of high-quality products; (2) conservative utilization of the hardware retained. The most reliable silicon semiconductors available are used, in conservatively designed, heavily derated circuits.

The number of components has been held to a minimum by extensive time-sharing of functional circuits since component life in electronic circuits is not a function of the frequency of operation.

This approach means that the PRODAC 50 will *not* be the weak link in plant reliability. When located in an environment suitable for human operators, statistical reliability analysis indicates availability of 99.9% may be expected.



what maintenance is needed?



Maintenance also is reduced virtually to an elementary "cookbook" procedure. Careful functional packaging was the rule in this all-Westinghouse computer development. Every component pertaining to a particular "bit," for example, is contained in a single, large printed circuit card. Correction of a fault associated with one bit requires only replacement of one card—no time is lost locating the source of the trouble.

The PRODAC 50 is designed to provide long, reliable service in any environment where human beings can work. Unless plant conditions are unusually severe, no special facilities are required for temperature or humidity control. Westinghouse will make recommendations on instrumentation and wiring and, if the user wishes, will provide sensors and associated wiring.

how about details?

- The PRODAC 50 is a solid-state, 14-bit, high-speed, additive computer system designed specifically for process control in real-time, on-line applications.
- Operation is parallel, binary, stored-program, single address. Indirect addressing is possible on all instructions or commands.
- Logic is diode-coupled NAND.
- Construction is pre-wired, wire-wrapped panel and printed circuit board. Inter-panel connections are by cable with plug-in connectors.
- Memory is magnetic ferrite core, 4096 words base, expandable in 4K increments to 16K (16,384 words).
- Core cycle time is 4.5 microseconds.
- Included in the 25 instructions are 5 comparison designators which are set on every operation.
- Temperature limits: 32 to 120°F (0–50°C) ambient.
- Accessibility from front only required for operation or maintenance. Rear opening provided for convenience in installation.
- Sixty-four channels by 64 word addresses by 14 bits addressing of the process is available, giving a theoretical capability of over 50,000 points.

Power required is less than 500 watts, single-phase, 120 volts, 60 cycle ac, with voltage tolerance of $\pm 10\%$. Memory is completely protected in the event of power failure and emergency operation by battery is available.

Analog-to-digital conversion is performed by a voltage-to-frequency converter and counter. Analog signals are treated by integration for exactly one cycle of the ac line, thereby canceling line-induced noise. Forty such conversions are made per second per converter at 0.1% tolerance, 50 mv full scale.

Digital input is provided by isolated 48-volt coupling circuits, while output is by means of mercury-wetted 100 va relays.

Up to 64 individual external interrupts can be obtained in blocks of 16.

Buffering either input or output conducted by software permitting use of full memory as single buffer or any combination or division.

Priority is by software for all central processor functions, interrupt priority being by hardware. Fourteen priority levels are standard.

Standard software (included with each system) presently includes:

Arithmetic routines—multiply, divide, sine, cosine, arctangent, natural log, exponential, square root.

Executive routines—priority, programmer's console, analog input, contact input, buffering decimal to binary conversion.

Application routines—(for general use, not including adaptation to a specific system)—steam tables, analog scan, contact scan, monitoring and limit checking.

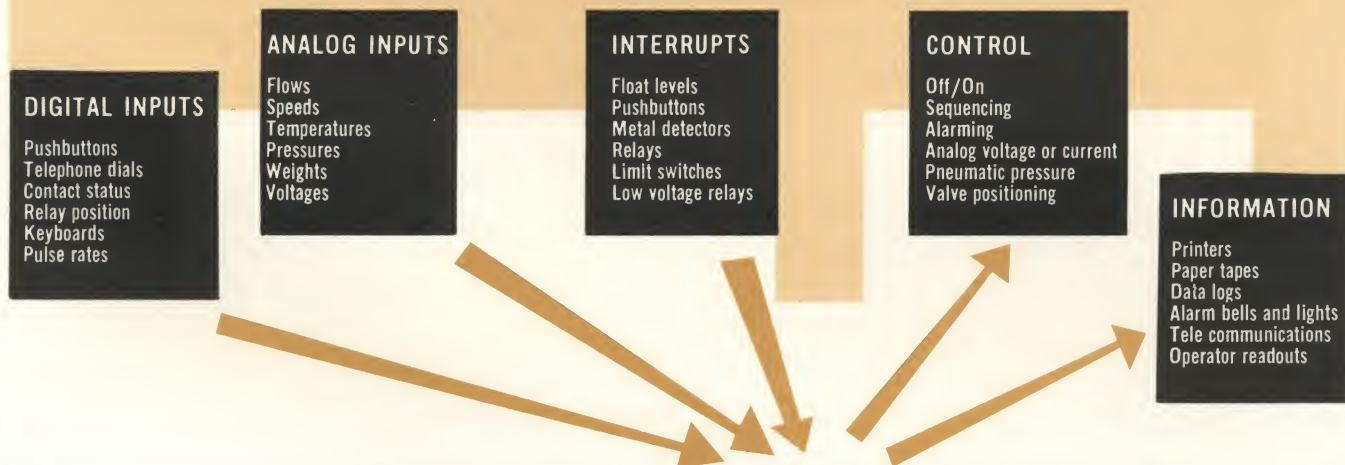
Additional programs will be added to the library as they are developed and are available to all users.



PRODAC 50 instructions

Instruction	Mnemonic Symbol	Code	Computer Operation	Designators	Time (Cycles)
Add	ADD	10	$(A) + (Y) \rightarrow (A)$	SET	4
Subtract	SUB	11	$(A) - (Y) \rightarrow (A)$	SET	4
Enter A	ENL	32	$(Y) \rightarrow (A)$	SET	4
Store A	STL	37	$(A) \rightarrow (Y)$	SET	4
Exclusive OR	EOR	13	$(A) + (Y) \rightarrow (A)$	SET	4
Logical Product of (A) & (Y)	AND	12	$(A) \& (Y) \rightarrow (A)$	SET	4
Right Shift one place (End Off-sign extended)	RSH	16	$(Y) R_1 \rightarrow (Y)$	SET	4
Left Shift one place (End around)	LSH	14	$(Y) L_1 \rightarrow (Y)$	SET	4
Decrement	DCR	01	$(Y) - 1 \rightarrow (Y)$	SET	3
Set Most Sig. Bit	SMB	03	SET $(Y)_{13}$	SET	3
CLR Most Sig. Bit	CMB	02	CLR $(Y)_{13}$	SET	3
Enter Designators	EDR	05	$(Y_{4-0}) \rightarrow (DES)$		3
Store Designators	SDR	06	$(DES) \rightarrow (Y_{4-0})$	KEEP	3
Input	INP	30	$I/O \rightarrow (A)$	SET	4
Output	OUT	34	$(A) \rightarrow I/O$	SET	4
Jump	JMP	24	$Y \rightarrow (P)$	KEEP	3
Set Lockout and Jump	SLJ	22	$Y \rightarrow (P)$, Set Interrupt Lockout	KEEP	3
CLR Lockout and Jump	CLJ	23	$Y \rightarrow (P)$, Clear Interrupt Lockout	KEEP	3
Jump on Zero	ZJP	20	$Y \rightarrow (P)$ if 0 Desig. Set	KEEP	3, 2
Jump on Pos.	PJP	27	$Y \rightarrow (P)$ if POS Desig. Set	KEEP	3, 2
Jump on Even	EJP	21	$(Y) \rightarrow (P)$ if EVEN Desig. Set	KEEP	3, 2
Jump on End Around Carry	CJP	25	$Y \rightarrow (P)$ if EAC DES Set	KEEP	3, 2
Jump on Overflow	OJP	26	$Y \rightarrow (P)$ if OVERFL DES Set	KEEP	3, 2
Return Jump	RJP	36	$(P) \rightarrow (Y) Y \rightarrow (P)$	KEEP	5
Stop	STP	00	STOP	CLR	3

(Note: One cycle = 4.5 μ sec.)



where can the **PRODAC 50** be used?

Because of the versatility of modular hardware and stored programs, the PRODAC 50 can be applied to virtually any kind of work in any industry. This flexibility often permits the PRODAC 50 to perform the

functions of a card programmer, or as the controller for a single device, for lower cost than a special purpose device.

Here are a few examples of ways in which the PRODAC 50 can be used:

functionally,

Data Logging
Monitoring and Alarming
Operator Guidance
Analog Loop Set Point Control
Direct Digital Control

Instrument Calibration
Indication of Trends and/or Averages
Sequence Control
Feedback, feed forward (anticipatory) control
Multi-variable integration

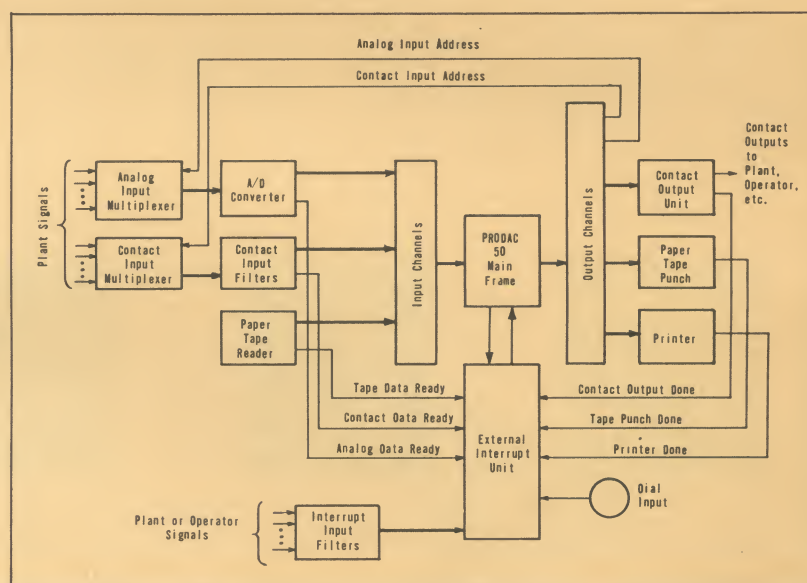
process control applications

Processes and/or process control tasks—among many for which the Westinghouse PRODAC 50 may be employed—include:

Metal rolling mills
Demand control and limiting
Sequencing and timing
Control for machine tools
Automatic warehousing
Sorting and recording
Automatic train control
Conveyor automation
Web control (for example, paper or textile)
Material processing—kilns, grinders, crushers, etc.
Production scheduling
Maintenance scheduling and recording
Process simulation
Automatic dispatching
Electric furnace control
Building services control and recording

Hoist control/skip control
Work station monitoring
Power plant control
Production line testing and recording
Batch control
Production reporting
Carriage drives
Metal coating lines
Inspection and Gageing
Filling, packaging, weighing
Blending
Material transport and pumping
Remote station control
Laboratory operations
Water system control

**TYPICAL
SYSTEM
BLOCK
DIAGRAM**



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